

# SPACE SHUTTLE MAIN ENGINE

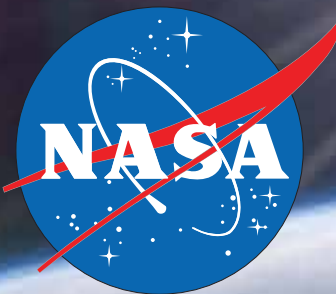
## Main Combustion Chamber-Powerhead

*Built by Pratt & Whitney Rocketdyne for NASA*

### Main Combustion Chamber (MCC) and Powerhead Working Together

The Fuel and Oxidizer Preburners located in the Powerhead (on each side of the Main Injector) combust hydrogen and oxygen at an extremely fuel-rich mixture ratio, and thus supply hot gas at variable rates to drive the High Pressure Fuel and Oxidizer Turbopumps. Hydrogen also flows through the Powerhead including the Main Injector and both Preburners to provide cooling of the hot gas walls.

The Powerhead and the MCC together combine to generate the engine's thrust through combustion. The combustion of the propellants is initiated by the Powerhead's 600 Main Injector coaxial elements at a mixture ratio of six parts oxygen to one part hydrogen. An Augmented Spark Igniter (ASI) system chamber is located in the center of the Main Injector. Small quantities of hydrogen and oxygen are continuously injected into this chamber and initially ignited by two spark igniters located therein. This flame then ignites the propellants flowing through the injector elements into the combustion chamber. The MCC contains the combustion process, accelerates the gas flow to throat sonic velocity, and initiates the gas expansion process through its diverging section. The hot gas wall of the MCC is cooled by hydrogen flowing through 430 channels cut into its liner.



Pratt & Whitney Rocketdyne

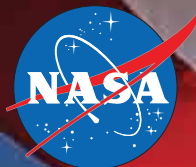


# Main Combustion Chamber Fantastic Facts

## Main Combustion Chamber (MCC) Unit 2014

Completed on July 15, 1981

- Accumulated a total of 93 starts and 39320 seconds of hot fire time.
- Traveled a total of 12.9 million miles.
- Every second a half ton of propellant enters the MCC (1,085 lbm/sec) and combusts at a temperature of 6,000 °F (degrees Fahrenheit).
- The combustion gases exit at a velocity of 7,000 mph, about 10 times the speed of sound.
- The 430 coolant channels on the unique copper alloy liner have a wall as thin as a paper clip at the hottest spot near the throat.
- The MCC coolant circuit starts with cryogenic propellant hydrogen fuel 3 times as cold as dry ice and exits as gaseous fuel. Each coolant molecule spends only 2 milliseconds in the MCC.
- The coolant inlet pressure is equivalent to an ocean depth of 2.5 miles.



# Mission Highlights for this Main Combustion Chamber



STS-6 / Challenger  
April 4, 1983  
Mission: Tracking and Data Relay Satellite-1 (TDRS-1)  
First flight of Challenger.  
First space walk of 4 hours, 17 minutes and was performed by astronauts Donald Peterson and F. Story Musgrave.



STS-8 / Challenger  
August 30, 1983  
Mission: Multipurpose Satellite  
This mission was the first night launch and landing.



STS-61C / Columbia  
January 12, 1986  
Mission: SATCOM KU-1  
The mission was piloted by Charles Bolden and included mission specialist U.S. Representative Bill Nelson.



STS-7 / Challenger  
June 18, 1983  
Mission: Communications Satellite.  
This mission featured the first US woman in space, astronaut Sally Ride.



STS-41B / Challenger  
February 3, 1984  
Mission: WESTAR-VI, Manned Maneuvering Unit  
This mission was the first KSC landing and featured the first un-tethered space walks performed by astronauts Bruce McCandless II and Robert Stewart.

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## Mission Highlights for this Powerhead



STS-55 / Columbia  
April 26, 1993  
Mission: D-2 Spacelab  
The 2nd flight of the German managed D-2 Spacelab



STS-58 / Columbia  
October 18, 1993  
Mission: SLS-2  
The 2nd Space Lab Life Sciences mission



STS-62 / Columbia  
March 4, 1994  
Mission: Microgravity Payload-2, and Office of Aeronautics and Space Technology-2



STS-64 / Discovery  
September 9, 1994  
Mission: LITE; SPARTEN-201  
1st in-space use of Lidar (Light detection and ranging)



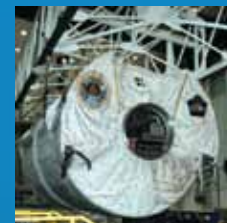
STS-63 / Discovery  
February 3, 1995  
Mission: SPACEHAB -3  
1st flight of a female pilot, Eileen Collins.  
1st shuttle approach and fly-around of Mir



STS-69 / Endeavour  
September 7, 1995  
Mission: SPARTEN 201-3; WSF-2  
1st time 2 primary payloads were deployed and retrieved in the same mission



STS-76 / Atlantis  
March 22, 1996  
Mission: Third Shuttle-Mir Docking; SPACEHAB Transport of Shannon Lucid to Mir as the 1st America woman to live on the Mir space station



STS-83 / Columbia  
April 4, 1997  
Mission: MSL-1  
1st flight of the Microgravity Science Lab

## Powerhead Fantastic Facts

**Powerhead Unit 4007**  
Completed April 27, 1992

- The SSME is built around the Powerhead, and also serves as the structural backbone for the SSME
- The Powerhead Main Injector has 600 elements
- The Powerhead Main Injector injects a half ton of propellant into the Main Combustion Chamber every second of operation (1085 lbm/sec)
- The Fuel Preburner chamber combustion temperature is approximately 1500 degrees Fahrenheit
- The Main Injector element discharge pressure is approximately 3000 psi
- The Preburner element outlet pressures are approximately 5000 psi



